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CJM-32

JULY 20, 1961

FINAL ENGINEERING REPORT

SIGNAL CORPS BATTERY CHARGING SYSTEM

PP2386

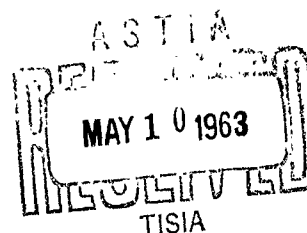
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CJM:DS

FINAL ENGINEERING REPORT
SIGNAL CORPS BATTERY CHARGING SYSTEM PP2386

- REFERENCES:
1. SPECIFICATION SCL-1833
 2. APPENDIX A - VIBRATION TEST REPORT
 3. APPENDIX B - HANDBOOK
 4. APPENDIX C - COST REDUCTION SUGGESTIONS

GENERAL:

FOR A COMPLETE DISCUSSION OF THE SYSTEM SEE APPENDIX B.

PREVIOUS HISTORY:

THIS COVERS THE TIME PERIOD FROM THE AWARDING OF THE CONTRACT TO THE DELIVERY OF THE FIRST PROTOTYPE TO SIGNAL CORPS.

FOLLOWING ARE THE MAJOR AMMENDMENTS AND ADDITIONS TO SCL-1833 AGREED TO BY SIGNAL CORPS AND SORENSEN:

- A. THE MAGAMP CIRCUITRY WOULD BE THE BRIDGE TYPE RATHER THAN THE DOUBLER TYPE.
- B. AIR SWITCHES RATHER THAN THERMOSTATIC SWITCHES WOULD BE USED.
- C. SHIELDED BEARINGS WITH BEACON GREASE, ESSO STD. PER MIL-G-3278 SHALL REPLACE THE SILICONE LUBRICATED SEALED BALL BEARINGS IN THE BLOWER MOTOR.
- D. A 100 AMP OUTPUT BREAKER WITH SUITABLE SHUNT TO BE USED SINCE 200 AMP BREAKERS WERE NOT AVAILABLE.
- E. THE ONLY PRECAUTION TAKEN AGAINST ACID AND ACID FUMES TO BE ACID-RESISTANT PAINT.
- F. RIPPLE TO BE 1% RMS MAX. AND TO BE MET ONLY AT NORMAL ROOM AMBIENT.
- G. CIRCUIT STABILITY OVER THE TEMPERATURE RANGE TO BE $\pm 1\%$ FOR A 20°C CHANGE WITH LINE, LOAD, AND FREQUENCY HELD CONSTANT.

THE FIRST PROTOTYPE DELIVERED TO SIGNAL CORPS INCORPORATED OR MET ALL OF THE ABOVE REQUIREMENTS.

CURRENT HISTORY:

THIS COVERS THE TIME PERIOD FROM THE DELIVERY OF THE FIRST PROTOTYPE TO THE DELIVERY OF THE THREE PRODUCTION UNITS IN JULY 1961.

JULY 20, 1961

AFTER REVIEWING AND TESTING THE FIRST PROTOTYPE, SIGNAL CORPS INFORMED SORENSEN OF THE REDESIGN NECESSARY TO MAKE THE UNIT COMPLY WITH THE SPECIFICATIONS. INCLUDED WITH THIS WAS A LIST OF MINOR MECHANICAL MODIFICATIONS SIGNAL CORPS DESIRED INCLUDED IN THE UNIT. UPON REVIEWING THE ENGINEERING, SORENSEN INITIATED A NUMBER OF CHANGES WHICH WERE APPROVED BY SIGNAL CORPS. ALL OF THESE CHANGES WERE INCORPORATED IN THE THREE PRODUCTION UNITS DELIVERED TO SIGNAL CORPS IN JUNE OF 1961. FOLLOWING IS A DESCRIPTION OF THE CHANGES:

A. INPUT TRANSFORMER -

THE FIRST PROTOTYPE TRANSFORMER HAD AN EXCESSIVE TEMPERATURE RISE OF 140°C . THIS, PLUS AN AMBIENT OF 55°C , GIVES A MAXIMUM TEMPERATURE OF 195°C . INVESTIGATION SHOWED THAT SUFFICIENT REDUCTION IN TEMPERATURE RISE, TO MEET MIL-T-27, CLASS T REQUIREMENTS (170°C MAX.), COULD NOT BE REALIZED USING THE EXISTING CORE. THE NEXT LARGER CORE WAS GREATER IN SIZE THAN NECESSARY. IT WAS DECIDED, IN VIEW OF THE 10,000 HOUR LIFE REQUIREMENT, TO USE THE FULL POTENTIAL OF THE CORE; AND THIS, ALONG WITH EXTRA VENTING OF THE BASE PLATE TO RELIEVE HOTSPOTS, RESULTED IN A GOOD CONSERVATIVE DESIGN. THE FINAL TRANSFORMER MEETS ALL THE REQUIREMENTS OF MIL-T-27, GRADE 6, CLASS T. TESTS ON THE NEW UNIT GAVE THE FOLLOWING RESULTS:

TEMPERATURE RISE	80°C MAX.
PLUS AMBIENT	55°C
MAX. TEMPERATURE	135°C

B. MAGAMP INDUCTORS -

THE TEMPERATURE RISE ON THE PROTOTYPE MAGAMPS WAS 100°C . THE DESIGN, THEREFORE, WAS CHANGED FROM MIL-T-27, CLASS S, (130°C MAX.) TO MIL-T-27, CLASS T (170°C MAX.).

- C. THE BASE OF THE POWER SUPPLY WAS REDESIGNED TO MEET THE VIBRATION SPEC., AND ALSO TO ACCOMMODATE THE LARGER TRANSFORMER. THE BASIC DESIGN WAS RETAINED, BUT THE MATERIAL WAS INCREASED IN THICKNESS. CROSSMEMBERS WERE ADDED FOR STIFFENING, AND U-BRACKETS WERE PLACED UNDER THE MOUNTING LIPS TO STRENGTHEN THEM. 100% STRENGTH-WELDING WAS USED THROUGHOUT.

TESTS ON THE BASE PLATE, WITH ALL WOUND COMPONENTS MOUNTED TO IT, WERE PERFORMED BY YORK RESEARCH CORP. OF STAMFORD, CONN. A COPY OF THEIR RESULTS IS INCLUDED, AS APPENDIX A, WITH THIS REPORT.

- D. STRUCTURAL SKINS WERE REVIEWED USING, AS A GUIDE, THE REPORTS ON THE VIBRATION TESTS OF THE PROTOTYPE. STRENGTHENING AND STIFFENING MEMBERS WERE ADDED WHEREVER IT WAS NECESSARY TO ENSURE COMPLIANCE WITH THE VIBRATION SPECIFICATIONS.

- E. TOGGLE SWITCHES WERE CHANGED TO M.S. TYPE.

- F. STAINLESS STEEL HARDWARE WAS USED THROUGHOUT THE SYSTEM.
- G. THE WRITING TABLE WAS STRENGTHENED BY THE ADDITION OF TWO SUPPORT BRACKETS; ONE PLACED ON EITHER SIDE OF THE POWER SUPPLY OPENING.
- H. THE WRITING TABLE LAMP WAS MOUNTED ON AN EXTENDED BRACKET AND FACED INWARD TO AVOID GLARE IN THE OPERATOR'S EYES.
- I. THE OUTPUT TERMINALS WERE SPACED FURTHER APART, AND THE DOOR ENCLOSING THEM WAS ENLARGED, TO ALLOW BETTER WRENCH MANIPULATION.
- J. GROMMET MATERIAL WAS ADDED TO ALL ROUGH SURFACES WHERE THERE WAS A DANGER OF ABRADING THE WIRES.
- K. THE CABLES WERE ARRANGED FOR LESS STRESS, AND FOR NEATER CONNECTION TO THE TERMINAL STRIPS.
- L. THE TERMINAL STRIPS WERE MOUNTED WITH FOUR SCREWS INSTEAD OF TWO, AND INSULATED MARKING-STRIPS WERE USED BENEATH THEM.
- M. SOLDERED CONNECTIONS WERE TREATED WITH ANTI-FUNGICIDAL VARNISH OVER THE COMPLETE JOINT AND EXPOSED PORTION OF THE WIRES.
- N. FINISHES WERE CHECKED TO MAKE CERTAIN THEY WERE IN ACCORD WITH MIL-F-4072. THE ONE EXCEPTION TO THE MIL REQUIREMENT IS THE EXTERNAL ACID RESISTANT PAINT. SPECIAL ATTENTION WAS PAID TO THE CAPACITOR AND RESISTOR MOUNTING BRACKETS. THE FINISHES USED ORIGINALLY ON THESE PARTS MEET ALL THE REQUIREMENTS OF THE MIL SPECS., AND PAST SORENSEN EXPERIENCE SHOWS THAT THEY ARE MORE THAN ADEQUATE. HOWEVER, THE BRACKETS ARE PURCHASED, STRIPPED, AND REFINISHED, AND DIFFICULTIES HAVE BEEN EXPERIENCED IN THE PAST BECAUSE OF POOR STRIPPING TECHNIQUES. SINCE THEN, THIS TROUBLE HAS BEEN COMPLETELY ELIMINATED.
- O. THE ACID RESISTANT PAINT USED ON THE PROTOTYPE IS OBSOLETE. THE MANUFACTURER ASSURED SORENSEN THAT THE NEW PAINT IS EQUAL OR SUPERIOR TO THE OLD, AND THAT COLOR-MATCHING IS NO PROBLEM.
- P. THE THERMISTORS ARE ENCAPSULATED WITH "CYCLEWELD" RATHER THAN "GREEN GLAZE" AS ORIGINALLY REQUESTED BY SIGNAL CORPS. THE MANUFACTURER INFORMED US THAT "GREEN GLAZE" IS NOT COMPATIBLE WITH THE MATERIAL IN THE THERMISTORS WE ARE USING. THEY FURTHER STATED THAT "CYCLEWELD" WILL MEET ALL THE REQUIREMENTS OF THE TEMPERATURE AND HUMIDITY SPECS.
- Q. THE BLOWER MOTOR BEARINGS WERE CHANGED TO SHIELDED BEARINGS USING TEXACO 500 LUBRICANT. THIS WAS A RECOMMENDATION FROM THE MANUFACTURER; PRIOR APPROVAL WAS OBTAINED FROM SIGNAL CORPS.

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- R. THE OUTPUT CIRCUIT BREAKER IN THE POWER SUPPLY WAS CHANGED TO A 200 AMPERE UNIT. BECAUSE 200 AMPERE BREAKERS WERE NOT AVAILABLE AT THAT TIME, THE PROTOTYPE WAS SUPPLIED WITH A 100 AMPERE UNIT AND SUITABLE SHUNTS. SINCE THEN 200 AMPERE BREAKERS HAVE BECOME AVAILABLE, AND BECAUSE OF THEIR GREATER SIMPLICITY AND RELIABILITY, IT WAS DECIDED TO USE THEM.
- S. PILOT LITES ON STATIONS 11 & 12 WERE REWIRED TO PREVENT THEIR DIMMING ON CONSTANT CURRENT CHARGING.
- T. THE VOLTMETER PUSHBUTTON SWITCHES ON STATIONS 11 & 12 WERE CHANGED TO D.P.D.T. TYPES. THIS, ALONG WITH REWIRING, WAS DONE TO PREVENT THE ACCIDENTAL DISCHARGE OF A CONSTANT POTENTIAL STATION INTO A LOWER VOLTAGE CONSTANT CURRENT STATION THROUGH THE COMMON VOLTMETER CIRCUITRY.

CJM:ds

APPENDIX A

REPORT No. ET-1301 DATE 10/12/60
SUBJECT VIBRATION TEST ON BATTERY
CHARGER BASE PLATE
CLIENT SORENSEN & COMPANY
SOUTH NORWALK, CONNECTICUT

ADMINISTRATIVE DATA

TEST REPORT No.: ET-1301

CLIENT: SORENSEN & COMPANY
RICHARDS AVENUE
SOUTH NORWALK, CONNECTICUT

UNIT TESTED: ONE BATTERY CHARGER BASE PLATE

SPECIFICATIONS: SCL-1833

PURPOSE OF TEST: TO DETERMINE IF ANY RESONANT
FREQUENCIES BELOW 55 CYCLES PER
SECOND ARE PRESENT.

SECURITY CLASSIFICATION: NONE

PURCHASE ORDER No.: 6110-70-7812

DATE TEST COMPLETED: OCTOBER 11, 1960

TEST CONDUCTED BY: YORK RESEARCH CORPORATION
ONE RESEARCH DRIVE
STAMFORD, CONNECTICUT

DISPOSITION OF SPECIMEN: RETURNED TO CLIENT

VIBRATION TEST

PROCEDURE:

THE BATTERY CHARGER BASE PLATE AS RECEIVED FROM SORENSEN & COMPANY, INC., WAS MOUNTED ON THE VIBRATION FIXTURE PLATE. THE FIXTURE AND UNIT WERE THEN CHECKED AND THE CENTER OF GRAVITY ESTABLISHED IN EACH OF THE THREE PLANES. FOLLOWING THIS IT WAS MOUNTED BY THE SUSPENSION METHOD IN ITS NORMAL MOUNTING POSITION AND IN TURN CONNECTED TO THE VIBRATION TABLE WITH A DRIVE ROD. THE UNIT WAS VIBRATED SUCCESSIVELY IN THREE MUTUALLY PERPENDICULAR DIRECTIONS, WHICH WERE RESPECTIVELY PARALLEL TO THE EDGES OF THE UNIT FROM 10 TO 55 CPS. THE FREQUENCY RANGE FROM 10 TO 55 CPS WAS TRAVERSED BY HAND AT 1 CYCLE PER SECOND INCREMENTS WITH A CONSTANT TOTAL EXCURSION OF 0.0156 INCH. IN THE FREQUENCY RANGE FROM 10 TO 55 CPS, A FREQUENCY WAS USED ONLY LONG ENOUGH TO DETERMINE WHETHER A RESONANCE WAS PRESENT. A STROBOTAC WAS USED TO DETECT RESONANCE.

RESULTS:

NO RESONANCES BELOW 55 CYCLES PER SECOND WERE DETECTED. ALSO THERE WAS NO EVIDENCE OF PHYSICAL DAMAGE TO THE UNIT AS A RESULT OF THE ABOVE TEST.



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SIGNAL CORPS BATTERY CHARGING SYSTEM

PP 2386

HANDBOOK

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SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOKI. SYSTEM GENERALDESCRIPTION

THE SYSTEM IS COMPOSED OF THREE ASSEMBLIES -- THE POWER SUPPLY, THE CONTROL AND DISTRIBUTION PANEL, AND TWELVE BATTERY CHARGING STATIONS -- ARRANGED WITHIN A 12 FT. BY 4 FT. RECTANGLE. THE POWER SUPPLY AND CONTROL PANEL FORM ONE 4 FT. END, AND THE TWELVE STATIONS ARE ARRANGED, SIX PER SIDE, ALONG THE 12 FT. LENGTH. THE OVERALL SYSTEM HEIGHT IS 5 FT. (APPROX.).

THE POWER SUPPLY IS A SELF CONTAINED, REGULATED UNIT MOUNTED ON CASTERS, AND CAN, THEREFORE, BE USED FOR PURPOSES OTHER THAN BATTERY CHARGING. THE OUTPUT OF THE SUPPLY IS 24 TO 32 VOLTS D.C. AT 0 TO 200 AMPERES D.C. IT FITS INTO A CUTOUT IN THE CONTROL AND DISTRIBUTION PANEL, TO WHICH IT CAN BE MECHANICALLY FASTENED.

THE OUTPUT OF THE SUPPLY IS FED TO THE CONTROL AND DISTRIBUTION PANEL AND FROM THERE TO THE TWELVE CHARGING STATIONS. THE CONTROL PANEL CONTAINS FACILITIES FOR ADJUSTING AND MONITORING THE VOLTAGE AND CURRENT TO EACH STATION.

CAPABILITIES

SIMULTANEOUS CHARGING OF TWELVE 24 VOLT BATTERIES WITHIN AN 8 TO 12 HOUR PERIOD UNDER A NORMAL AMBIENT TEMPERATURE OF 20°C. (A 24 VOLT BATTERY IS DEFINED AS ANY BATTERY, OR BATTERIES SERIES CONNECTED, HAVING A NOMINAL VOLTAGE OF 24, AND A CAPACITY OF 150 AMPERE-HOURS AT THE 20 HOUR RATE.)

CHARGING METHODS

MODIFIED CONSTANT POTENTIAL METHOD - STATIONS 1 TO 10

MODIFIED CONSTANT POTENTIAL METHOD

AND

- STATIONS 11 AND 12

CONSTANT CURRENT METHOD

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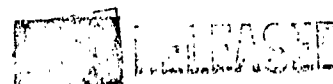
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II. POWER SUPPLY SPECIFICATIONS

<u>TYPE</u>	-	MAGNETIC AMPLIFIER
<u>INPUT</u>		
VOLTAGE	-	200 TO 253 VOLTS A.C. RMS. L-L
PHASE	-	3
FREQUENCY	-	60 CPS. $\pm 5\%$
INPUT CURRENT	-	40 AMPS PER LINE (MAX.)
<u>OUTPUT</u>		
VOLTAGE	-	24 TO 32 VOLTS D.C.
CURRENT	-	0 TO 200 AMPERES D.C.
RIPPLE	-	0.32 VOLTS RMS. MAX. FOR RESISTANCE LOAD OVER THE VOLTAGE AND CURRENT RANGE SPECIFIED.
REGULATION	-	$\pm 1.0\%$ MAX. THROUGHOUT THE SPECIFIED VOLTAGE RANGE FOR THE MAXIMUM SIMULTANEOUS VARIATION OF LINE VOLTAGE, LINE FREQUENCY, AND LOAD CURRENT.
STABILITY	-	$\pm 1.0\%$ FOR A 20°C CHANGE WITH LINE, LOAD, AND FREQUENCY HELD CONSTANT.
RESPONSE TIME	-	0.1 SECONDS MAX. (63% RECOVERY OF MAXIMUM EXCURSION FOR A $\pm 5\%$ LINE CHANGE AND ANY LOAD CHANGE BETWEEN 0 AND FULL LOAD).
<u>OPERATING TEMPERATURE RANGE</u>	-	0 TO 132°F CONTINUOUS EXPOSURE AT HIGH TEMPERATURE EXTREME NOT TO EXCEED 4 HOURS. EXPOSURE AT LOW TEMPERATURE EXTREME NOT TO EXCEED 72 HOURS.



SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOK

III. PRINCIPLES OF OPERATION1. POWER SUPPLY1.1 PRELIMINARY EXPLANATION (REFER TO BLOCK DIAGRAM FIG. 1)

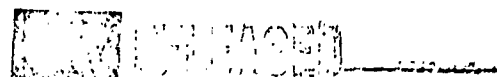
UNREGULATED THREE PHASE AC IS APPLIED TO THE INPUT TRANSFORMER. THE TRANSFORMER STEPS THE VOLTAGE DOWN AND APPLIES IT TO THE MAGNETIC AMPLIFIERS WHICH ACT AS VARIABLE IMPEDANCE DEVICES. THE OUTPUT OF THE MAGNETIC AMPLIFIERS IS RECTIFIED BY A THREE PHASE BRIDGE CIRCUIT, AND THEN PASSED THROUGH A FILTERING STAGE TO THE OUTPUT TERMINALS OF THE SUPPLY.

REGULATION OF THE DC OUTPUT VOLTAGE IS ACCOMPLISHED BY COMPARING THE OUTPUT TO A VOLTAGE REFERENCE (POWER REFERENCE). THE DIFFERENCE BETWEEN THE TWO VOLTAGES IS FED BACK AS AN ERROR SIGNAL TO THE MAGNETIC AMPLIFIERS. THE IMPEDANCE OF THE MAGNETIC AMPLIFIERS IS A FUNCTION OF THE ERROR SIGNAL, AND THE DC OUTPUT, IN TURN, IS DEPENDENT UPON THE IMPEDANCE OF THE MAGNETIC AMPLIFIERS. THE WHOLE CIRCUIT FORMS A SELF-CORRECTING FEEDBACK LOOP THAT KEEPS THE DC OUTPUT VOLTAGE CONSTANT.

1.2 MAGNETIC AMPLIFIERS (REFER TO SIMPLIFIED SCHEMATIC FIG. 2)

A DETAILED EXPLANATION OF THE THEORY OF MAGNETIC AMPLIFIERS IS BEYOND THE SCOPE OF THIS MANUAL. IN SIMPLE TERMS, HOWEVER, THE AC WINDINGS ON THE MAGNETIC AMPLIFIER MAY BE CONSIDERED TO ACT AS "GATES" WHICH OPEN AT SOME TIME DURING THE HALF-CYCLE THAT THE RECTIFIERS CR3 ALLOW CONDUCTION. UNTIL THE GATE OPENS, NO CURRENT FLOWS. AFTER THE GATE OPENS, CURRENT FLOWS AND IS RESTRICTED ONLY BY THE IMPEDANCE OF THE LOAD CIRCUIT. THE AVERAGE CURRENT, AND HENCE THE VOLTAGE, IS CONTROLLED BY THE FRACTION OF THE HALF-CYCLE PERIOD THAT THE GATE IS OPEN. FOR EXAMPLE, IF THE INPUT VOLTAGE IS REDUCED, THE CURRENT FLOW DURING THE CONDUCTION PERIOD WILL BE REDUCED, THEREFORE, THE GATE MUST BE OPENED EARLIER TO MAINTAIN THE SAME OUTPUT VOLTAGE.

THE "GATING" ACTION RESULTS FROM THE CHANGE IN THE AC WINDING FROM A HIGH TO A LOW IMPEDANCE AT THE MOMENT THE CORE SATURATES. IN THE UNSATURATED CONDITION THE AC WINDING IS INDUCTIVE AND PRESENTS A LARGE REACTIVE IMPEDANCE TO THE AC VOLTAGE (GATE SHUT). WHEN THE CORE IS SATURATED, HOWEVER, IT CAN NO LONGER SUPPORT THE INDUCTIVE EFFECT AND THE IMPEDANCE OF THE AC WINDING DROPS PRACTICALLY TO ZERO (GATE OPENED). THE POINT ON THE AC HALF-CYCLE AT WHICH THE CORE SATURATES (FIRING POINT) IS CONTROLLED BY THE CURRENT IN THE DC WINDING. ADDING CONTROL AMPERE-TURNS WITH THE SAME POLARITY AS THE POWER AMPERE-TURNS, AS DETERMINED BY THE RECTIFIERS CR3, WILL ADVANCE THE FIRING POINT CAUSING AN INCREASE IN THE OUTPUT VOLTAGE. CONVERSELY REDUCING THE CONTROL AMPERE-TURNS WILL RETARD THE FIRING POINT, THEREBY DECREASING THE OUTPUT VOLTAGE.



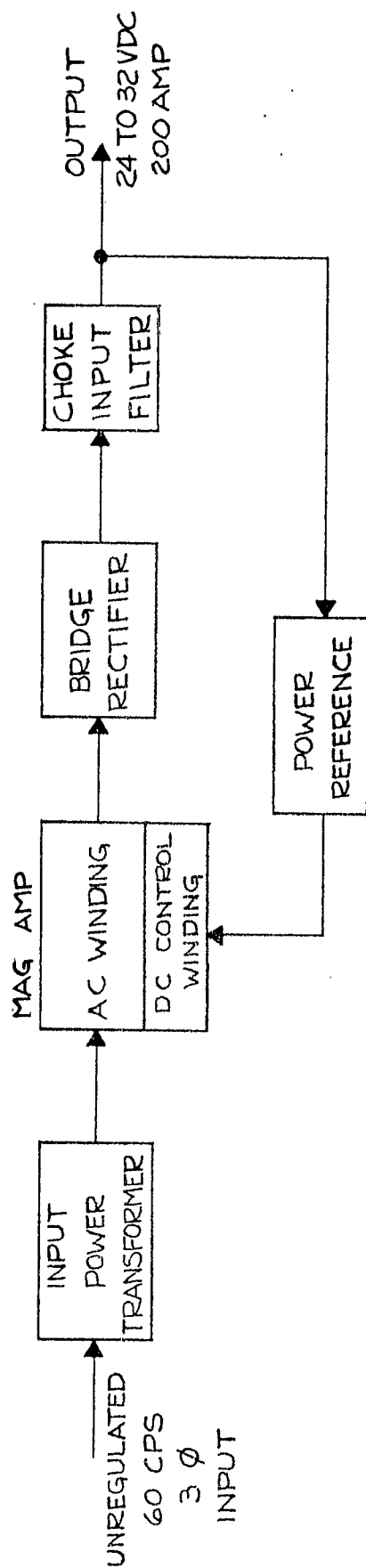


FIG. 1

BLOCK DIAGRAM
POWER SUPPLY
SIGNAL CORP BATTERY CHARGER
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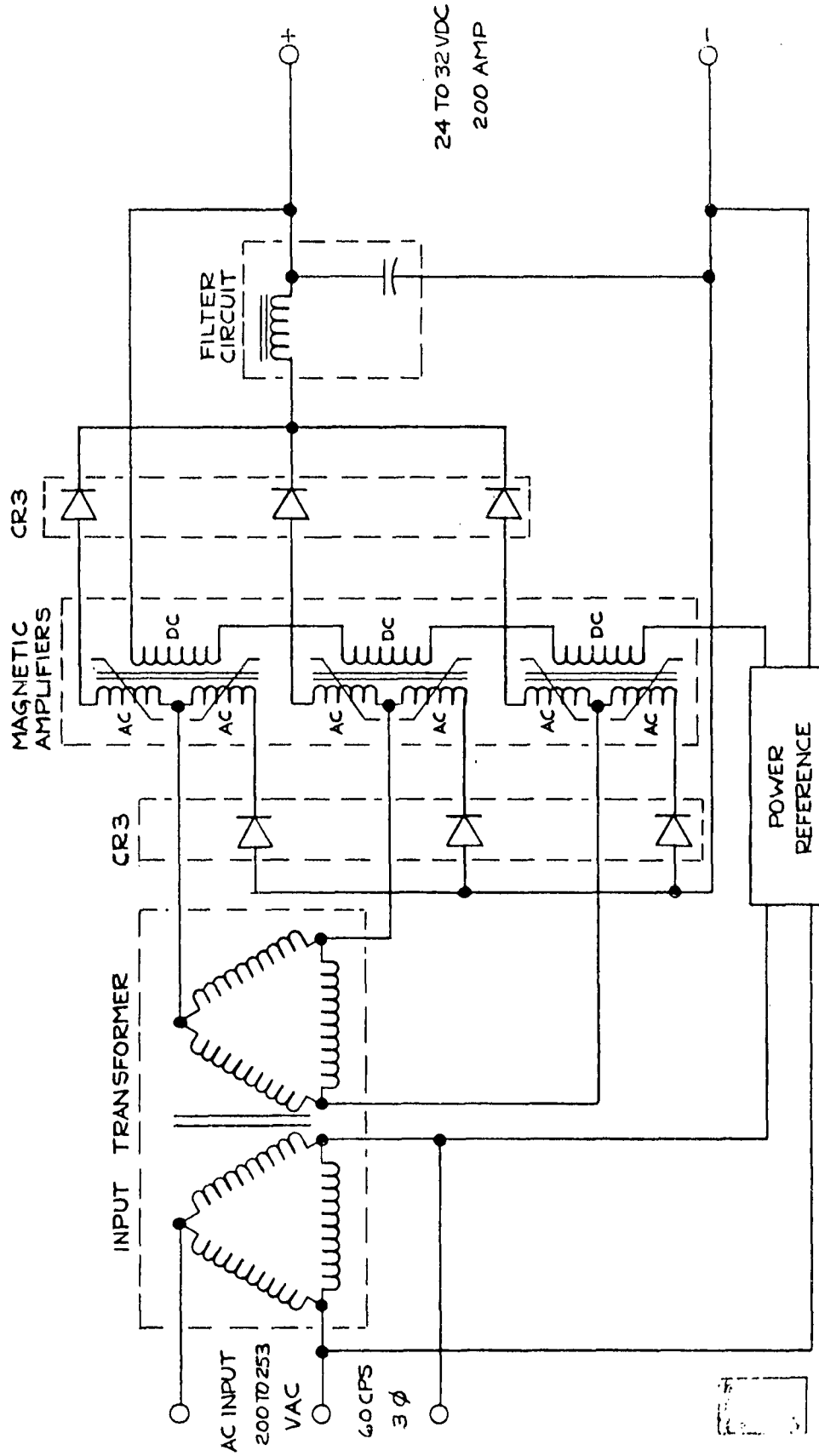


FIG. 2

SIMPLIFIED SCHEMITIC
POWER SUPPLY
SIGNAL CORP BATTERY CHARGER PP2386

SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOK

1.3 CONTROL CIRCUIT

THE OUTPUT OF THE UNIT IS COMPARED DIRECTLY TO A REFERENCE THROUGH THE CONTROL WINDINGS OF THE MAGNETIC AMPLIFIERS. ANY CHANGE IN THE OUTPUT VOLTAGE, DUE TO LINE OR LOAD CHANGES, PRODUCES AN "ERROR" VOLTAGE ACROSS THE CONTROL WINDINGS. THIS VOLTAGE CAUSES A CURRENT FLOW WHICH CHANGES THE FIRING POINT OF THE MAGNETIC AMPLIFIERS, THUS CORRECTING FOR THE CHANGE IN OUTPUT. THE DEGREE OF CORRECTION, AND HENCE THE REGULATION ACCURACY, IS DETERMINED BY THE GAIN OF THE MAGNETIC AMPLIFIER CORE, THE WINDINGS, AND THE REGULATION ACCURACY OF THE REFERENCE.

1.4 POWER REFERENCE (REFER TO POWER REFERENCE SCHEMATIC FIG. 3)

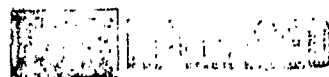
THE REFERENCE FOR THE POWER SUPPLY IS A SERIES TRANSISTOR VOLTAGE REGULATOR. THE ULTIMATE REFERENCE SOURCE, HOWEVER, IS THE SILICON DIODE, CR2, OPERATED IN ITS ZENER OR REVERSE CURRENT REGION. UNDER THIS CONDITION, A CONSTANT VOLTAGE WILL APPEAR AT THE TERMINALS OF THE DIODE AS THE CURRENT VARIES WITHIN CERTAIN LIMITS. CR2 IS IN ONE ARM OF A BRIDGE CIRCUIT WITH R7 THROUGH 13 FORMING THE OTHER THREE ARMS. THE BRIDGE IS ARRANGED SO THAT ANY CHANGE IN THE OUTPUT VOLTAGE WILL RESULT IN A CHANGE IN THE EMITTER-BASE CIRCUIT OF Q4.

THE SIGNAL BETWEEN THE EMITTER-BASE OF Q4 IS AMPLIFIED, IN TURN, BY TRANSISTOR Q4, Q3 AND Q2 AND THEN APPLIED TO THE BASE OF THE POWER TRANSISTOR Q1.

THE POWER TRANSISTOR Q1 REGULATES THE OUTPUT OF THE "POWER REFERENCE" BY VARYING THE VOLTAGE DROP FROM ITS EMITTER TO COLLECTOR IN ACCORDANCE WITH THE AMPLIFIED FEEDBACK SIGNAL APPLIED TO ITS BASE. Q1 IS IN SERIES WITH AN AUXILIARY POWER SUPPLY CONSISTING OF T2, CR1 AND C1. THIS SUPPLY IS CONNECTED TO THE INPUT POWER LINE. THE NEGATIVE SIDE OF THE AUXILIARY SUPPLY IS CONNECTED TO THE POSITIVE SIDE OF THE MAIN SUPPLY TO REDUCE THE POWER LOSS IN Q1.

R9 AND 10 ARE NEGATIVE TEMPERATURE COEFFICIENT RESISTORS WHICH ARE USED TO COUNTER BALANCE THE POSITIVE COEFFICIENT OF THE REMAINDER OF THE CIRCUIT.

COMPENSATION FOR INPUT LINE VOLTAGE CHANGES IS ACCOMPLISHED IN THE "POWER REFERENCE" BY APPLYING VOLTAGE FROM THE AUXILIARY POWER SUPPLY TO THE EMITTER OF Q4 THROUGH RESISTOR R4 AND R5.



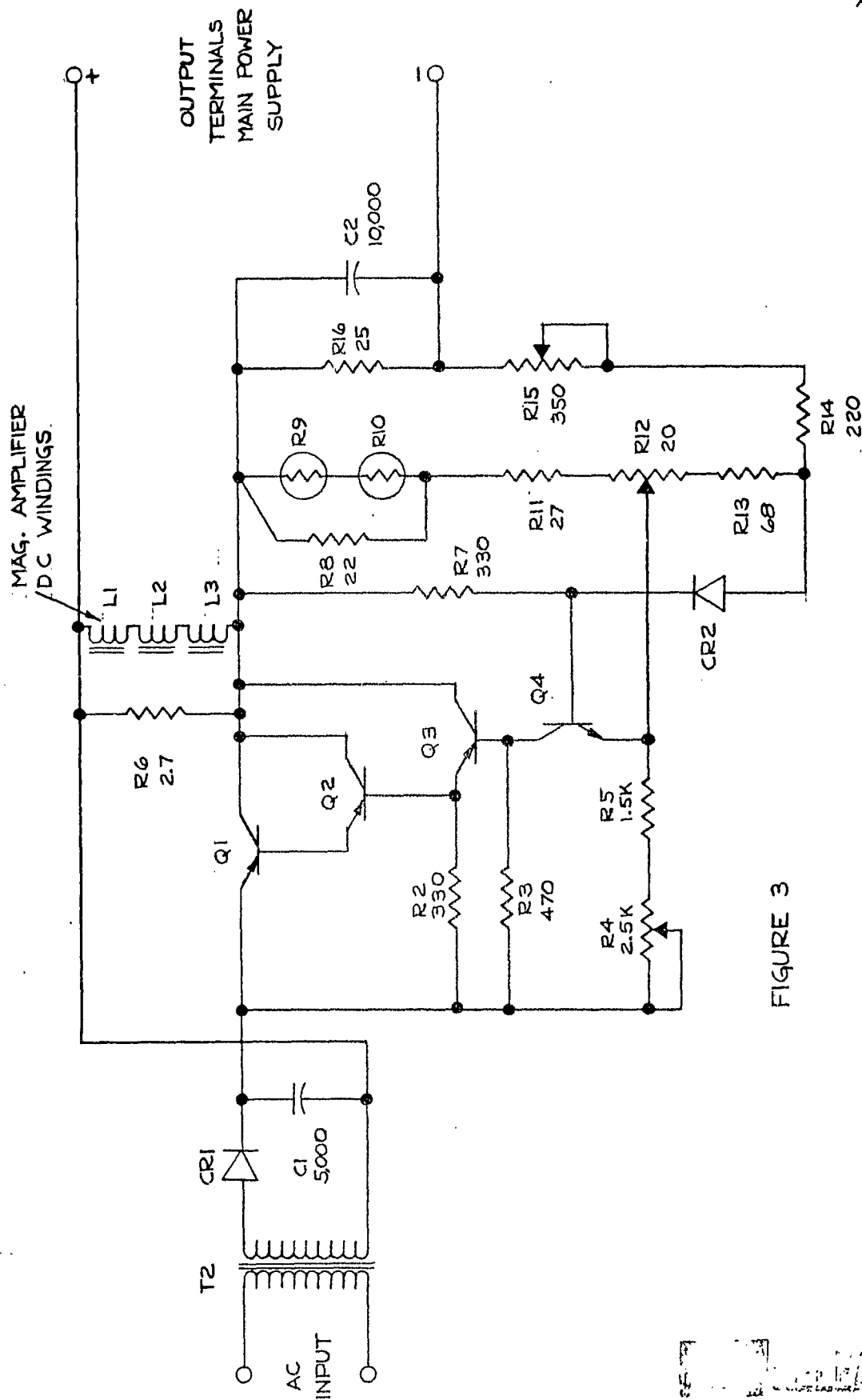


FIGURE 3

POWER REFERENCE SCHEMATIC
POWER SUPPLY
SIGNAL CORP BATTERY CHARGER PP2386

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SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOK

2. CONTROL AND DISTRIBUTION PANEL (REFER TO SCHEMATIC CONTROL AND DISTRIBUTION PANEL FIG. 4)2.1 CONSTANT POTENTIAL CHARGING

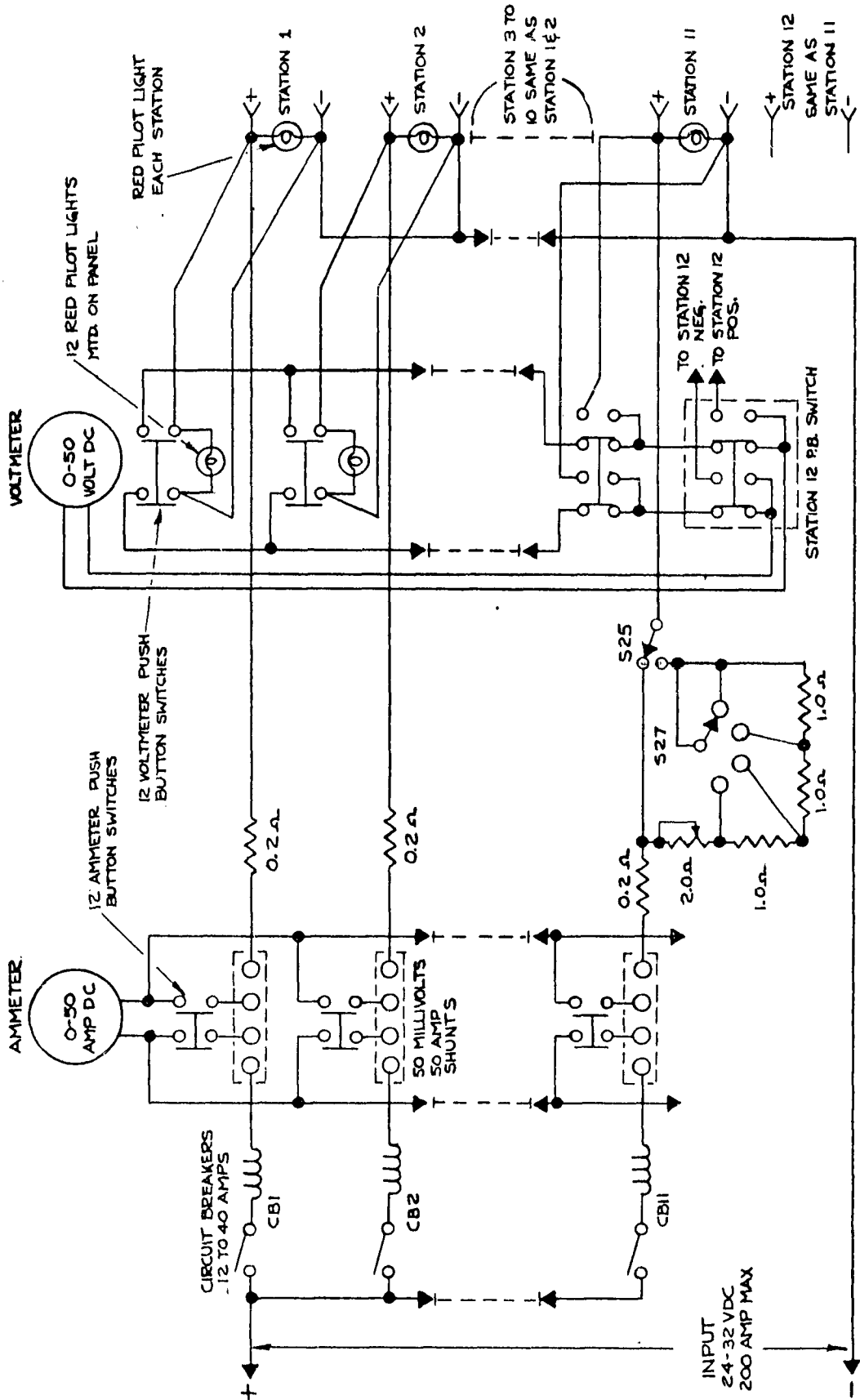
THE SCHEMATIC OF THE CONTROL PANEL IS SELF-EXPLANATORY. THE INPUT FROM THE POWER SUPPLY IS DIVIDED INTO TWELVE SEPARATE CHANNELS FEEDING THE TWELVE CHARGING STATIONS. ALL THE CHANNELS ARE EXACTLY ALIKE FOR CONSTANT POTENTIAL CHARGING. EACH HAS THE FOLLOWING EQUIPMENT MOUNTED ON THE PANEL.

- A. CIRCUIT BREAKER - 40 AMPERE, FOR OVERCURRENT PROTECTION AND MANUAL ON-OFF SWITCHING.
- B. CURRENT SHUNT - 50 AMPERE
- C. PUSHBUTTON-AMMETER - TO CONNECT THE AMMETER TO THE STATION SHUNT.
- D. PUSHBUTTON-VOLTMETER- TO CONNECT THE VOLTMETER TO THE STATION,
- E. PILOT LIGHT - RED, WHICH INDICATES STATION ENERGIZED

2.2 CONSTANT CURRENT CHARGING

STATIONS 11 AND 12 HAVE ADDED FACILITIES FOR CONSTANT CURRENT CHARGING. THE SWITCH-OVER FROM CONSTANT POTENTIAL TO CONSTANT CURRENT CHARGING IS ACCOMPLISHED BY S25. S27 IS A ROTARY SWITCH THAT SWITCHES IN RESISTORS TO ADJUST FOR THE VOLTAGE OF THE BATTERY UNDER CHARGE. THERE ARE FOUR POSITIONS -- 6, 12, 18 AND 24 VOLTS. THE 2 OHM POTENTIOMETER ADJUSTS THE CHARGING CURRENT TO THE DESIRED VALUE BETWEEN 5 AND 7 AMPS.

CAUTION: Do NOT EXCEED 7 AMPS ON CONSTANT CURRENT CHARGING.



SCHEMATIC CONTROL & DISTRIBUTION PANEL
SIGNAL CORP BATTERY CHARGER PP 2386

FIG. 4

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IV. INSTALLATION

THE SYSTEM IS SHIPPED IN FOUR SEPARATE SUB-ASSEMBLIES:

1. STATIONS 1 THRU 6
2. STATIONS 7 THRU 12
3. CONTROL & DISTRIBUTION PANEL
4. POWER SUPPLY

AN ASSEMBLY DRAWING AND WIRING DIAGRAM ARE INCLUDED WITH THE MANUAL FOR ASSEMBLY AND HOOKUP OF THE CHARGING STATIONS TO THE CONTROL PANEL (FIG. 5 & 6). IT IS ADVISABLE TO CHECK CORRECTNESS OF STATIONS TO PANEL WIRING BEFORE CONNECTING POWER SUPPLY. THE FOLLOWING PROCEDURE IS SUGGESTED:

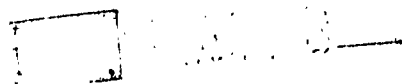
1. SWITCH ALL CIRCUIT BREAKERS ON PANEL TO OFF.
2. SWITCH TOGGLE SWITCHES, UNDER HEADINGS "POS-11" AND "POS-12" TO UP OR CONSTANT POTENTIAL POSITION.
3. CONNECT OHMMETER ACROSS TERMINALS E1 AND E2 ON CONTROL PANEL.
4. PLACE SHORTING JUMPER ACROSS PLUS (+) AND MINUS (-) TERMINALS AT STATION #1.
5. THROW STATION #1 CIRCUIT BREAKER ON.
6. OHMMETER SHOULD READ 0.2 OHMS (APPROXIMATE).
7. FOLLOW PROCEDURE IN STEPS 4 THRU 6 ON STATIONS 2 THRU 12.

THE POWER SUPPLY IS A SELF-CONTAINED UNIT MOUNTED ON CASTERS. IT FITS INTO A CUTOUT IN THE CONTROL PANEL TO WHICH IT IS MECHANICALLY FASTENED. TWO FLANGES MOUNTED BENEATH THE BASE ON EACH SIDE OF THE SUPPLY ENGAGE SIMILAR FLANGES ON THE PANEL. THE FLANGES ARE BOLTED TOGETHER TO SECURE THE SUPPLY.

EXTERNAL CONNECTIONS (POWER SUPPLY)

ALL EXTERNAL CONNECTIONS TO THE POWER SUPPLY ARE MADE TO A BOARD LOCATED BEHIND A DOOR ON THE UPPER RIGHT OF THE REAR PANEL. THE RECOMMENDED WIRE SIZE AND ROUTING ARE SHOWN IN FIG. 7.

NOTE: THE TERMINAL MARKED "GRD" ON TB4 IS PROVIDED FOR GROUNDING THE INPUT IF DESIRED.



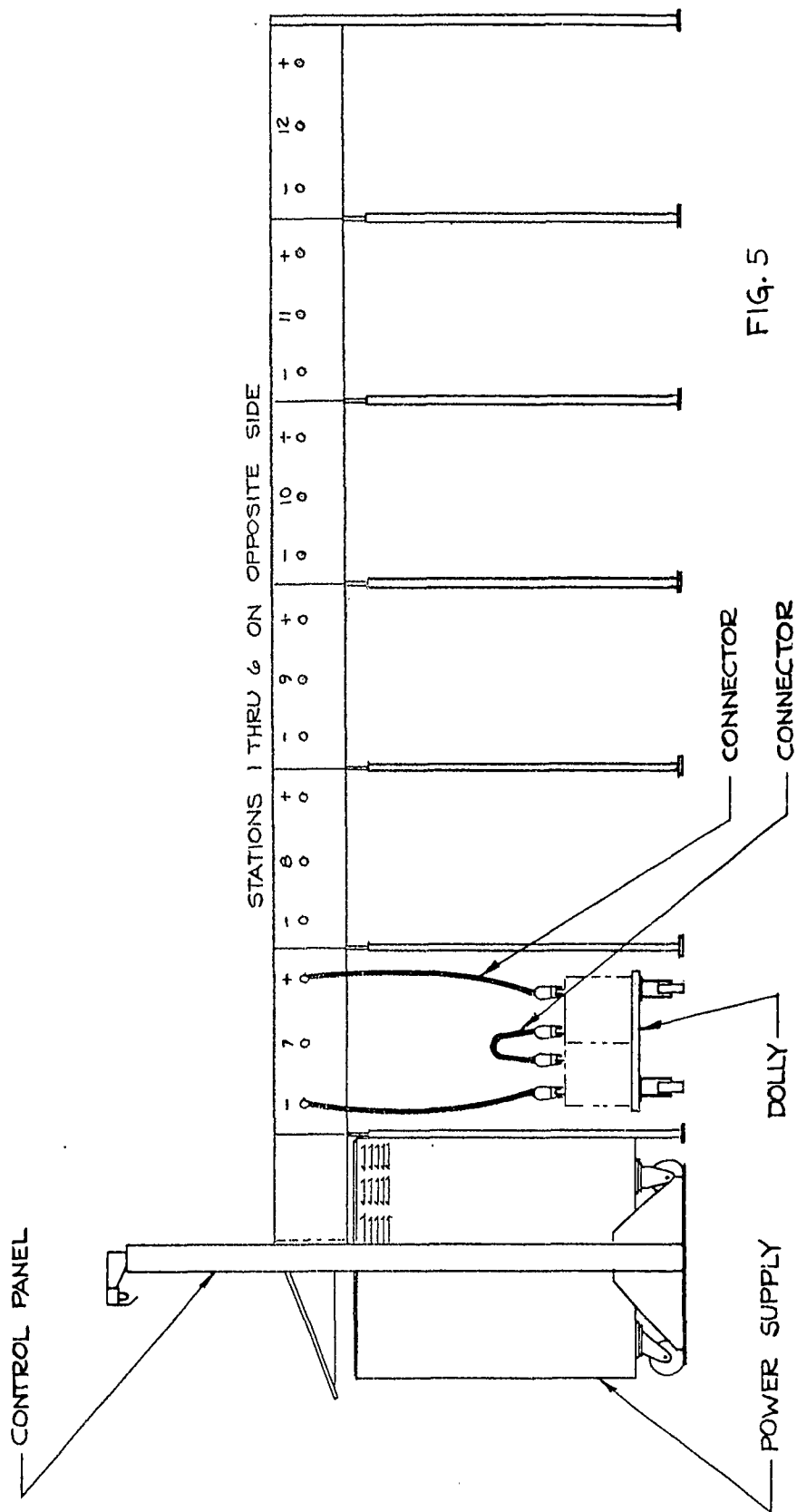


FIG. 5

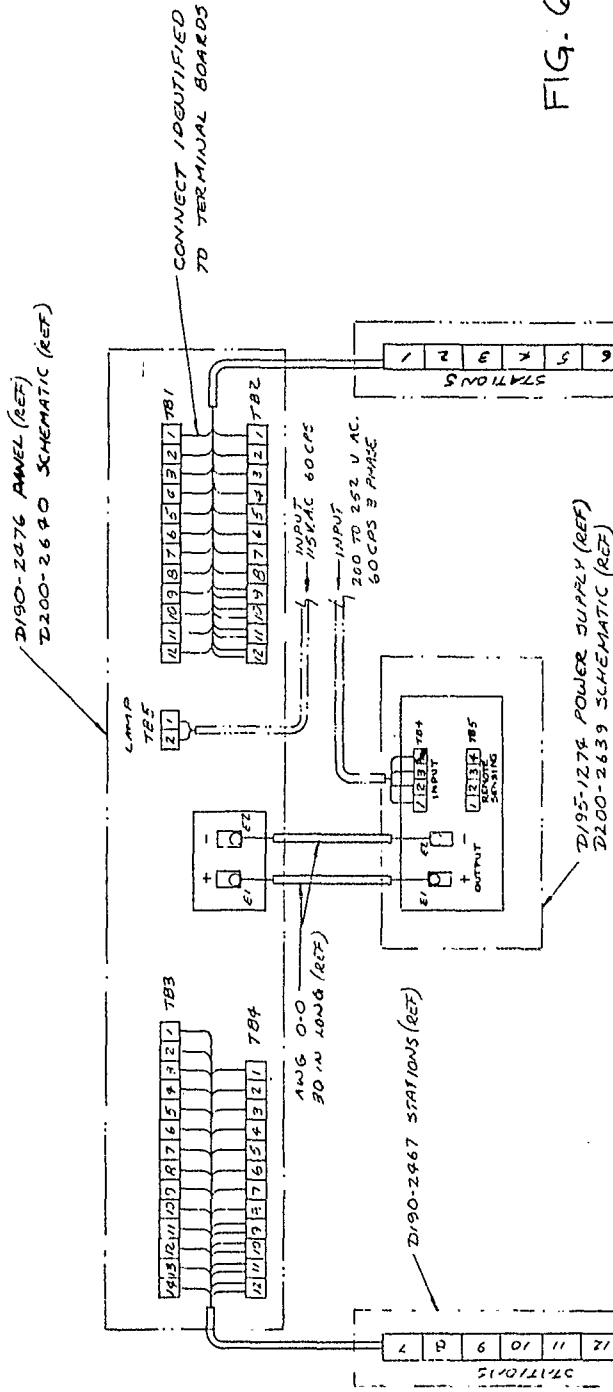


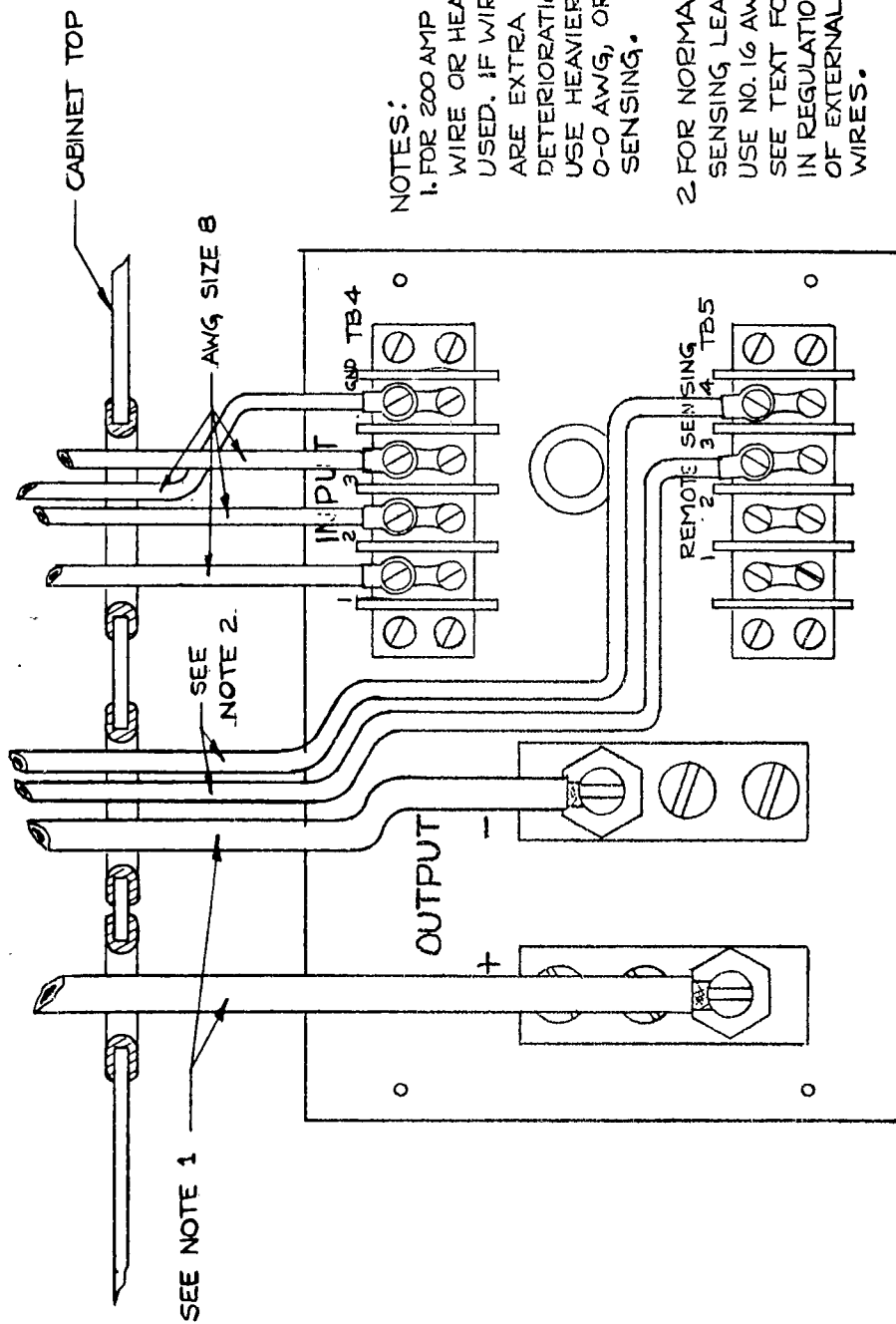
FIG. 6

STATION	TO TERM BD	AWG
1	7B3-1	10
2	7B3-2	10
3	7B3-3	10
4	7B3-4	10
5	7B3-5	10
6	7B3-6	10
7	7B3-7	10
8	7B3-8	10
9	7B3-9	10
10	7B3-10	10
11	7B3-11	10
12	7B3-12	10

STATION	TO TERM BD	AWG
1	7B3-1	10
2	7B3-2	10
3	7B3-3	10
4	7B3-4	10
5	7B3-5	10
6	7B3-6	10
7	7B3-7	10
8	7B3-8	10
9	7B3-9	10
10	7B3-10	10
11	7B3-11	10
12	7B3-12	10

STATION	TO TERM BD	AWG
1	7B3-1	10
2	7B3-2	10
3	7B3-3	10
4	7B3-4	10
5	7B3-5	10
6	7B3-6	10
7	7B3-7	10
8	7B3-8	10
9	7B3-9	10
10	7B3-10	10
11	7B3-11	10
12	7B3-12	10

		SMITH & CO. INC. SMITH BRIDGE CORP. 1010 KAM, ASSEMBLY BATTERY CHARGER 200-2639	
INCLUDE OPERATING INSTRUCTIONS DIMENSIONS ARE IN INCHES TOLERANCES ON DIMENSIONS ARE FRACTIONS DECIMALS ANGLES .0005 .001 .002 .005 .010 .020 .050 .100 .200 .500 1.000 2.000 5.000 10.000		DATE 11-11-50 DRAWN BY J. H. SMITH CHECKED BY J. H. SMITH SCALE 1" = 1"	
MATERIAL		PART NO. 200-2639	
PREPARED BY		NEXT ASSEMBLY	



NOTES:

1. FOR 200 AMP LOADS 0-0 AWG WIRE OR HEAVIER SHOULD BE USED. IF WIRES TO LOAD ARE EXTRA LONG CAUSING DETERIORATION IN REGULATION USE HEAVIER WIRE THAN 0-0 AWG, OR USE EXTERNAL SENSING.
2. FOR NORMAL LENGTH OF SENSING LEADS (UNDER 10 FT.) USE NO. 16 AWG OR HEAVIER. SEE TEXT FOR DETERIORATION IN REGULATION DUE TO SIZE OF EXTERNAL SENSING WIRES.

FIG. 7

EXTERNAL CONNECTION BOARD
POWER SUPPLY
SIGNAL CORP BATTERY CHARGER PF2386

SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOK

V. OPERATING INSTRUCTIONS1. POWER SUPPLY1.1 STARTING-UP PROCEDURE

REFER TO FRONT PANEL SKETCH FIG. 8.

1. MAKE CERTAIN OUTPUT CIRCUIT BREAKER (CB2) IS SWITCHED TO ON. THE LOAD SHOULD BE DISCONNECTED FOR THE PRELIMINARY START-UP, BUT DO NOT OPEN LOAD CIRCUIT BY SWITCHING CB2 TO OFF. UNIT WILL NOT OPERATE WITH CB2 OFF.
2. PRESS START BUTTON (PB1) AND HOLD IN.
3. SWITCH INPUT CIRCUIT BREAKER CB1 TO ON.
4. HOLD START BUTTON IN UNTIL BLOWER COMES UP TO SPEED.
5. RELEASE START BUTTON. IF INPUT CIRCUIT BREAKER (CB1) KICKS OFF, THE INPUT IS PHASED WRONG CAUSING THE BLOWER TO RUN BACKWARDS. INTERCHANGE ANY TWO INPUT CONNECTIONS ON TB4. REPEAT 2 TO 4.

NOTE: TRIPPING OF INPUT CIRCUIT BREAKER CAN ALSO BE CAUSED BY A FAULT CONDITION. SEE TROUBLE SHOOTING CHART ON PAGE 23.

1.2 COOLING

A BLOWER IS USED TO PROVIDE FORCED AIR COOLING. CARE SHOULD BE TAKEN TO INSURE THAT AIR FLOW IS NOT RESTRICTED. RESTRICTED AIR FLOW MAY CAUSE EXCESSIVE HEATING RESULTING IN SERIOUS DAMAGE TO VARIOUS COMPONENTS, PARTICULARLY THE SILICON RECTIFIERS.

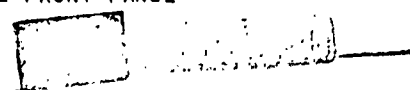
1.3 PROTECTIVE DEVICESFUSE

THE FUSE (F1) LOCATED ON THE FRONT PANEL IS FOR THE PROTECTION OF THE POWER REFERENCE CIRCUIT. THE FUSEHOLDER IS THE INDICATING LAMP TYPE WHICH LIGHTS WHEN THE FUSE IS BLOWN.

OVERCURRENT

INPUT - THE POWER SUPPLY IS PROTECTED FROM OVERCURRENT IN THE INPUT CIRCUITS BY A THREE PHASE CIRCUIT BREAKER (CB1).

OUTPUT - PROTECTION FROM OVERCURRENT IN THE OUTPUT OF THE SUPPLY IS PROVIDED BY A CIRCUIT BREAKER (CB2) WHICH ACTS TO REMOVE THE INPUT TO THE UNIT BY TRIPPING CB1. BOTH CIRCUIT BREAKERS ARE MOUNTED ON THE FRONT PANEL (SEE FIG. 8).



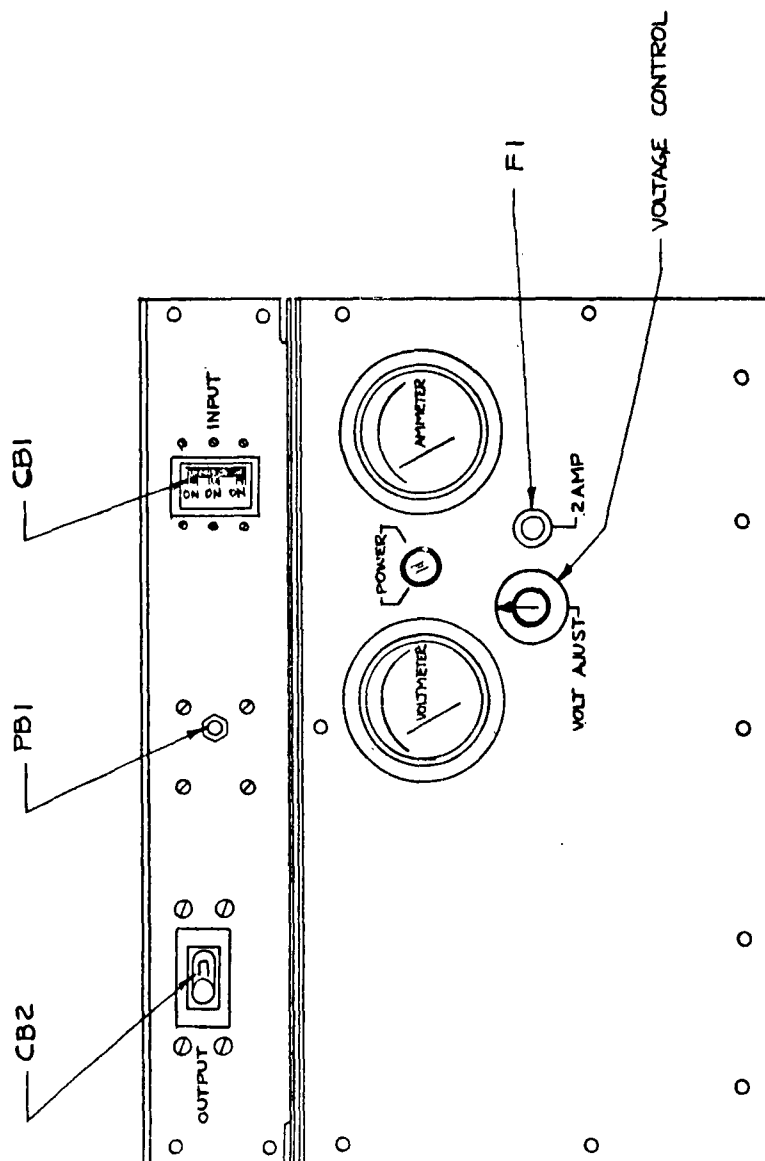


FIG. 8

FRONT PANEL
POWER SUPPLY
SIGNAL CORP BATTERY CHARGER PP2386

SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOK

FAN FAILURE:

AN AIR SWITCH IS MOUNTED IN EACH LEG OF THE BLOWER. WHEN THE AIR FLOW DROPS BELOW A CERTAIN VALUE, THE SWITCHES OPEN, TRIPPING CB1 AND THEREBY REMOVING THE INPUT POWER TO THE SUPPLY.

1.4 VOLTAGE CONTROL

A KNOB ON THE FRONT PANEL IS PROVIDED TO GIVE CONTINUOUS VARIATION OF OUTPUT VOLTAGE FROM 24 TO 32 VOLTS.

1.5 EXTERNAL SENSING

THE POWER SUPPLY IS PROVIDED WITH FACILITIES FOR REMOTE SENSING. THE CONNECTIONS ARE MADE AT THE BACK PANEL TO TB5 (SEE FIG. 7). THE UNIT IS SHIPPED WITH TB5 CONNECTED FOR INTERNAL SENSING AS SHOWN IN FIG. 9A. FIGURE 9B SHOWS THE CONNECTIONS FOR EXTERNAL SENSING, AND FIG. 9C SHOWS THE PROPER CONNECTIONS TO THE LOAD.

NOTES

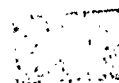
1. BE SURE THAT SENSING LEADS ARE CONNECTED TO THE PROPER POLARITY.
2. THE DETERIORATION OF REGULATION WITH RESISTANCE OF THE SENSING LEADS IS APPROXIMATELY 0.1% PER 0.1 OHM.

2. CONTROL AND DISTRIBUTION PANEL2.1 PANEL LAYOUT (SEE FIG. 10)

THE TOGGLE SWITCH ON THE EXTREME LEFT OF THE PANEL LABELED "LAMP" IS FOR THE DESK LAMP.

THE PANEL IS DIVIDED ROUGHLY IN HALF. THE LEFT SIDE CONTAINS THE VOLTMETER AND AMMETER AND A PILOT LIGHT, CIRCUIT BREAKER, VOLTMETER PUSHBUTTON, AND AMMETER PUSHBUTTON FOR EACH STATION. THE EQUIPMENT ASSOCIATED WITH EACH STATION IS ARRANGED IN A COLUMN AND THE COLUMNS ARE LABELLED "STATION 1 THROUGH 12".

ON THE RIGHT SIDE OF THE PANEL, UNDER THE HEADINGS "POS. 11" AND "POS. 12" ARE THE CONTROLS FOR CONSTANT CURRENT CHARGING ON STATIONS 11 AND 12.



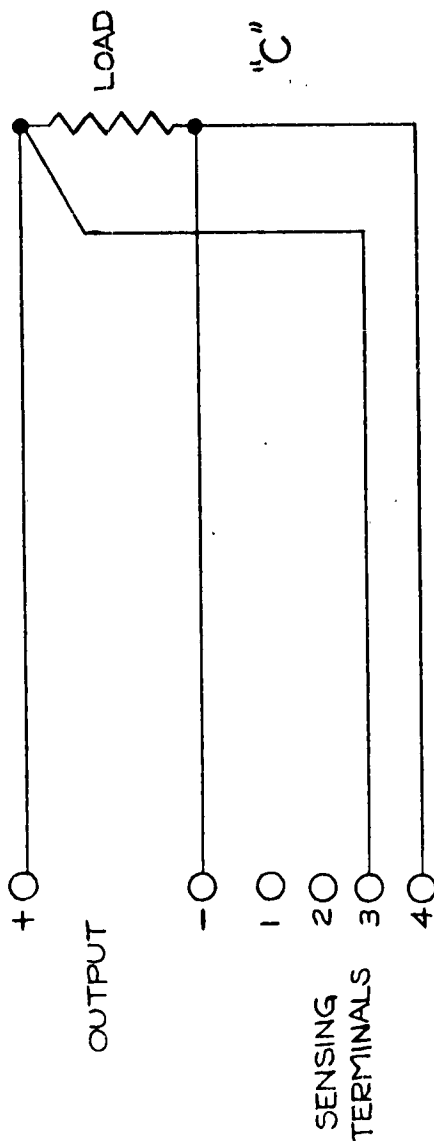
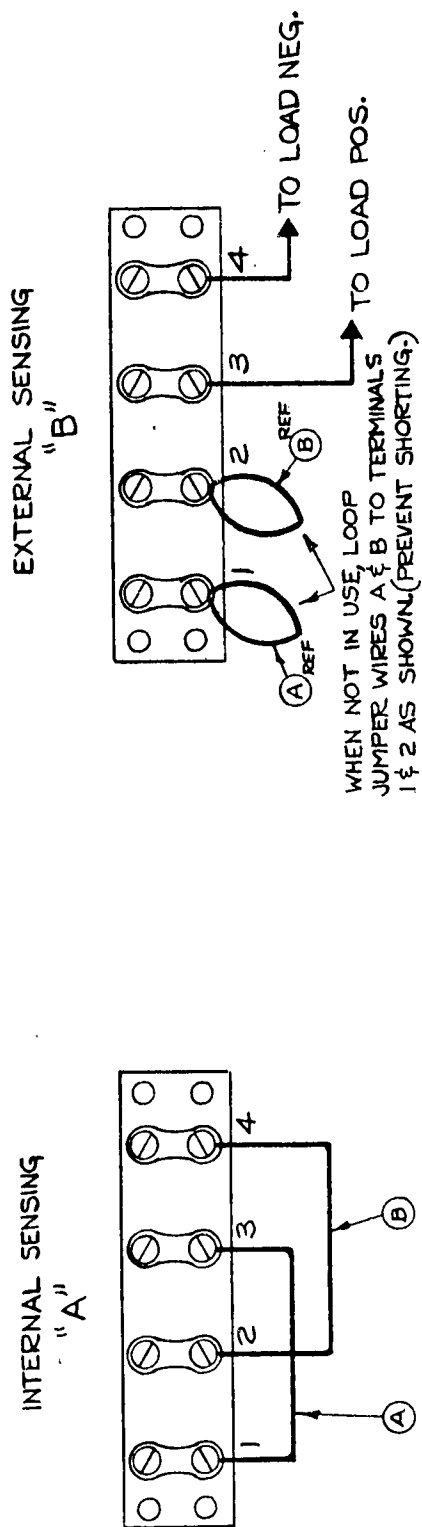


FIG. 9
SENSING ARRANGEMENT
POWER SUPPLY
SIGNAL CORP BATTERY CHARGER PP2386.

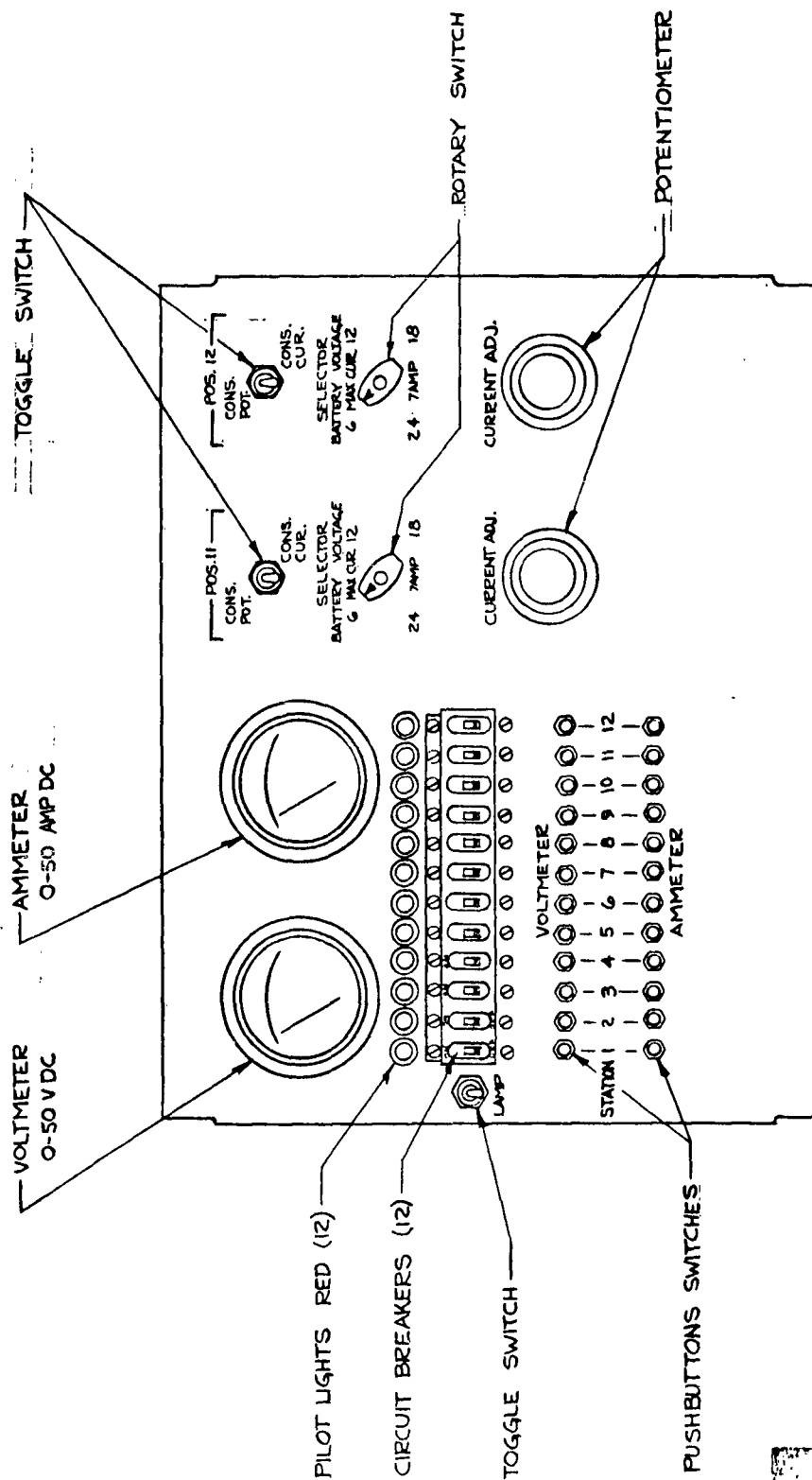


FIG. 10

CONTROL & DISTRIBUTION PANEL
FRONT VIEW
SIGNAL CORP BATTERY CHARGER PP2386

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2.2 CONSTANT POTENTIAL CHARGING

CAUTION: ONLY 24 VOLT BATTERIES MAY BE CHARGED BY THE CONSTANT POTENTIAL METHOD.

IT IS SUGGESTED THAT THE FOLLOWING PROCEDURE BE FOLLOWED:

1. DO NOT CONNECT BATTERY TO A STATION THAT IS ENERGIZED.
AN ENERGIZED STATION IS INDICATED BY BOTH THE PILOT LIGHT ON THE PANEL ASSOCIATED WITH THE STATION, AND THE PILOT LIGHT LOCATED AT THE STATION. TO SWITCH A STATION OFF, THROW APPROPRIATE CIRCUIT BREAKER ON PANEL TO OFF.
2. IF STATION 11 OR 12 ARE TO BE USED, MAKE CERTAIN THAT THE TOGGLE SWITCH LABELED "CONS. POT.," "CONS. CUR." IS IN THE UP OR CONSTANT POTENTIAL POSITION.
3. CONNECT BATTERY TO STATION.
 - A. IF NO OTHER STATIONS ARE IN OPERATION PROCEED AS FOLLOWS:
 1. READ BATTERY VOLTAGE AT PANEL BY DEPRESSING VOLTMETER PUSHBUTTON FOR THAT STATION.
 2. TURN POWER SUPPLY ON (SEE V, 1.1). SET POWER SUPPLY VOLTAGE APPROXIMATELY 2 VOLTS HIGHER THAN BATTERY VOLTAGE AS MEASURED IN PRECEDING STEP.
 3. TURN STATION ON BY SWITCHING STATION'S CIRCUIT BREAKER TO ON. MEASURE STATIONS CURRENT AND VOLTAGE AND ADJUST POWER SUPPLY OUTPUT FOR DESIRED CHARGING RATE.
 - B. IF OTHER CONSTANT POTENTIAL STATIONS ARE IN USE IT IS ONLY NECESSARY TO CONNECT BATTERY (STATION OFF) AND TURN STATION ON.
 - C. IF ONLY OTHER STATIONS IN OPERATION ARE ON CONSTANT CURRENT CHARGING PROCEED AS FOLLOWS:
 1. MEASURE CHARGING CURRENT TO CONSTANT CURRENT STATIONS AND NOTE.
 2. TURN CONSTANT CURRENT STATIONS OFF.
 3. CONNECT UP CONSTANT POTENTIAL STATIONS AS IN 1 TO 3A ABOVE.
 4. RESET CONSTANT CURRENT STATIONS TO CHARGING RATE AS NOTED ABOVE BY PROCEDURE 2.3.

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SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOK

2.3 CONSTANT CURRENT CHARGING

ONLY STATION 11 AND 12 ARE EQUIPPED FOR CONSTANT CURRENT CHARGING. 6, 12, 18 OR 24 VOLT BATTERIES MAY BE CHARGED BY THIS METHOD. THE FOLLOWING PROCEDURE SHOULD BE FOLLOWED:

1. MAKE CERTAIN STATION IS OFF BEFORE CONNECTING BATTERY.
2. CONNECT BATTERY AND READ ITS VOLTAGE AT PANEL.
3. THROW TOGGLE SWITCH FOR THAT STATION TO DOWN, OR CONSTANT CURRENT, POSITION.
4. TURN ROTARY SWITCH "SELECTOR, BATTERY VOLTAGE" TO POSITION AS INDICATED BY VOLTAGE READING IN 2 ABOVE.
5. TURN "CURRENT ADJ." POTENTIOMETER MAXIMUM COUNTER-CLOCKWISE.
6. IF NO OTHER STATIONS ARE IN USE TURN POWER SUPPLY ON (SEE V, 1.1) AND ADJUST OUTPUT TO APPROXIMATELY 24 VOLTS. IF OTHER STATIONS ARE IN USE DO NOT ADJUST POWER SUPPLY OUTPUT.
7. THROW STATION'S CIRCUIT BREAKER TO ON.
8. DEPRESS STATION'S AMMETER PUSHBUTTON TO READ CURRENT TO STATION AND TURN "CURRENT ADJ." POTENTIOMETER TO GIVE DESIRED CHARGING RATE. IF NO OTHER STATIONS ARE IN OPERATION THE VOLTAGE CONTROL ON POWER SUPPLY MAY ALSO BE USED TO ADJUST CHARGING RATE.

CAUTION: DO NOT EXCEED 7 AMPERES ON CONSTANT CURRENT CHARGING.

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SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOK

VI. MAINTENANCE AND REPAIR

DURING NORMAL LIFE, THE BATTERY CHARGING SYSTEM REQUIRES NO MAINTENANCE OTHER THAN THAT LISTED BELOW, AND THE CARE AFFORDED TO SIMILAR ELECTRONIC EQUIPMENT.

1. BLOWER-MOTOR LUBRICATION

THE FOLLOWING LUBRICATION SCHEDULE IS RECOMMENDED BY THE MOTOR MANUFACTURER:

- | | | | |
|----|--------------|-------|---|
| A. | 10,000 HOURS | ----- | APPLY SIX DROPS OF WINDSORLUBE
DIRECTLY INTO BEARINGS. |
| B. | 15,000 HOURS | ----- | APPLY SIX DROPS OF WINDSORLUBE
DIRECTLY INTO BEARINGS. |
| C. | 20,000 HOURS | ----- | BEARINGS SHOULD BE REPLACED. |

2. OUTPUT RANGE AND LINE COMPENSATION ADJUSTMENTS (REFER TO FIG. 11)

BEFORE SHIPMENT, EACH POWER SUPPLY IS TESTED AND PROPERLY ADJUSTED TO MEET SPECIFICATIONS. THEREFORE, IN NORMAL OPERATION, NO ADDITIONAL ADJUSTMENTS SHOULD BE NECESSARY. IF FOR ANY REASON (ACCIDENT OR REPLACEMENT OF COMPONENTS), THE UNIT REQUIRES ADJUSTMENT, THE PROCEDURE BELOW SHOULD BE FOLLOWED.

- A. SET INPUT VOLTAGE TO 225 VOLTS AND LOAD TO 100 AMPS. AT 28V DC
- B. ADJUST R12 SO THAT R15 (FRONT PANEL) COVERS OUTPUT RANGE FROM 24 TO 32 VOLTS.
- C. SET OUTPUT TO 28V DC AT 100 AMPS.
- D. ADJUST R4 TO GIVE MINIMUM CHANGE OF OUTPUT FOR LINE VARIATIONS FROM 200 TO 253 VOLTS. A CHANGE OF $0.1\% = .028$ VOLTS IS SUFFICIENT TO INSURE THAT UNIT WILL MEET TOTAL REGULATION SPECIFICATIONS.
- E. IT MAY BE NECESSARY TO RECENTER RANGE BY READJUSTING R12.



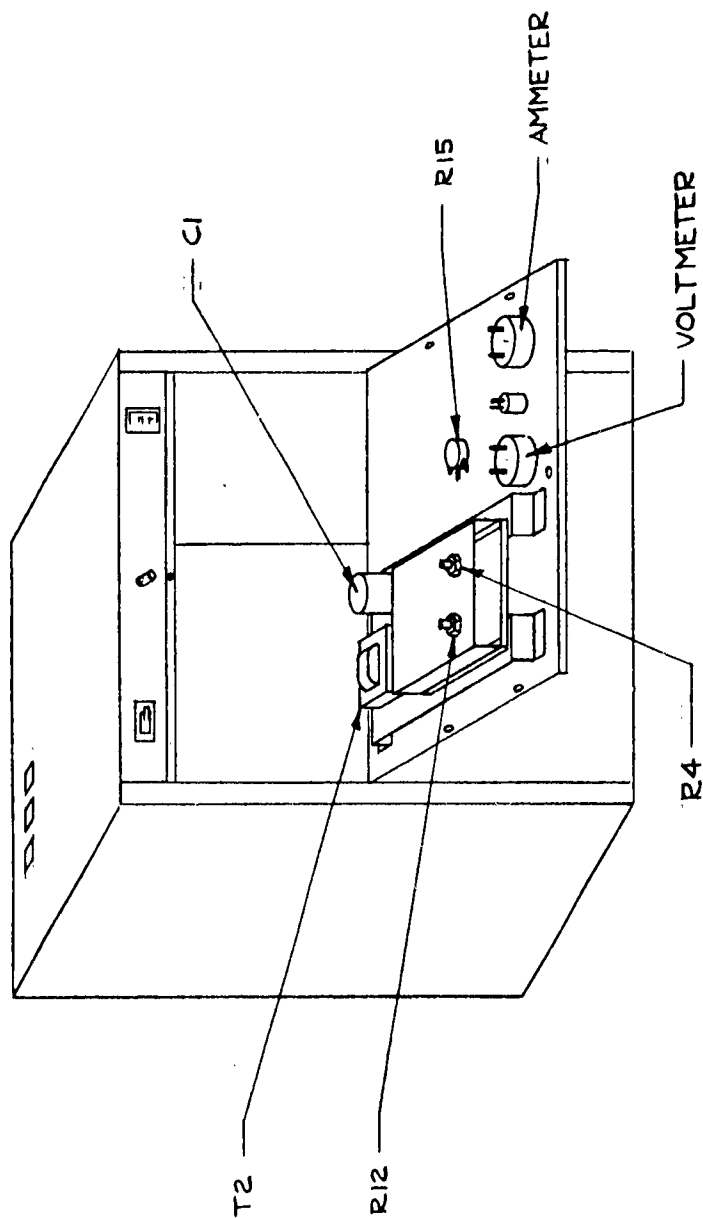


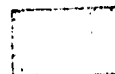
FIG. 11

FRONT PANEL OPEN POSITION
POWER SUPPLY
SIGNAL CORP BATTERY CHARGER PP2386

SIGNAL CORPS BATTERY CHARGING SYSTEM - HANDBOOK

POWER SUPPLYTROUBLE SHOOTING CHART

SYMPTOM	LIKELY CAUSE	PROCEDURE FOR REPAIR
INPUT BREAKER (CB1) (TRIPPING)	INPUT CONNECTED WRONG OUTPUT SHORTED (OUTPUT BREAKER CB2 WILL ALSO TRIP) SHORTED BLEEDER OR FILTER SHORTED POWER RECTIFIERS	SEE STARTING-UP PROCEDURE PAGE 7 DISCONNECT LOAD. CHECK LOAD FOR SHORT. CHECK C14 & R16 FOR SHORT. CHECK R17-20; CHECK C2-13 CHECK RECTIFIER STACK CR3
NO OUTPUT VOLTAGE	OPEN POWER OR FILTER CIRCUIT	CHECK FOR OPEN CIRCUIT IN T1, L1-3, L4, AMMETER SHUNT, CB2 COIL, OR CONNECTING WIRING
POOR REGULATION	FAILURE OF CR2 LINE COMPENSATION FAILURE	CHECK OR REPLACE CR2 CHECK R4 AND R5
HIGH OR LOW OUTPUT VOLTAGE	POWER REFERENCE FAILURE	CHECK POWER REFERENCE PER SCHEMATIC, TYPICAL CAUSES OF FAILURE Q1-4, CR2
HIGH RIPPLE	FILTER CIRCUIT FAILURE	CHECK INPUT LINE BALANCE AND MAG AMP BALANCE. CHECK CAPACITORS C2-13 AND L4



REPLACEMENT PARTS LIST

Model POWER SUPPLY PP2386 (BATTERY CHARGER SECTION I)

Serial No. to

Schematic Symbol	Description	Sorensen Part No.	Specifications
B1	BLOWER ASSEMBLY	91-1113	SORENSEN & Co.
C1	CAPACITOR, 5000 MFD, 10 VDC	24-976	SANGAMO DCM
C2-C14	CAPACITOR, 10,000 MFD, 50 VDC	24-980	SANGAMO DCM
CB1	CIRCUIT BREAKER	92-291	HEINEMANN TYPE XAM446-MG3
CB2	CIRCUIT BREAKER	92-290	HEINEMANN TYPE 60-133-1MG4
CR1	RECTIFIER	26-994	WESTINGHOUSE 341B
CR2	RECTIFIER	26-953	1N467
CR3	RECTIFIER ASSEMBLY	26-773	INTERNATIONAL RECTIFIER 66-2634
DS1	PILOT LIGHT	42-325	GENERAL ELECTRIC NE-51
	PILOT LIGHT HOLDER	43-303	MS35414-8
F1	FUSE, 2A, 250V	42-860	MS90078-11-1
	FUSE HOLDER	42-488	BUSSMAN TYPE HKL-X
L1-L3	MAGNETIC AMPLIFIER	126-2114	SORENSEN & Co.
L4	FILTER CHOKE	127-1490	SORENSEN & Co.
M1	AMMETER	94-417	SORENSEN & Co.
M2	VOLTMETER	94-531	SORENSEN & Co.
Q1	TRANSISTOR	18-058	2N174
Q2-Q3	TRANSISTOR	18-037	2N43A
Q4	TRANSISTOR	18-015	2N228
R1	RESISTOR, 3.1K OHMS, 38 W	28-485	RW35G312
R2	RESISTOR 330 OHMS, 1/2 W	28-186	RC20GF331K
R3	RESISTOR, 470 OHMS, 1/2 W	28-199	RC20GF471K
R4	POTENTIOMETER, 2.5K OHMS, 2 W	29-154	RA20LASB252A
R5	RESISTOR, 1.5K OHMS, 1/2 W	28-367	RC20GF152K

For Reference see
Schematic drawing

200-2639

dated

*

RECOMMENDED SPARE PARTS: This instrument normally requires the replacement only of tubes, pilot lamps, etc. However because of possible improper use, and because of the effects of high ambient and of certain kinds of tube failures (and of protective devices) we suggest that the parts marked with an asterisk be kept on hand. PLEASE REFERENCE THE MODEL AND SERIAL NUMBERS ON ALL PARTS ORDERS.

List No. 14-3255
Page 1 of 3
Prepared by J. CHAPKOVITCH
Date 11/15/60

REPLACEMENT PARTS LIST

Model POWER SUPPLY PP2386 (BATTERY CHARGER SECTION I)

Serial No. to

Schematic Symbol	Description	Sorensen Part No.	Specifications
R6	RESISTOR, 2.7 OHMS, 1W	28-202	RC32GF2R7K
R7	RESISTOR, 330 OHMS, 1/2 W	28-186	RC20GF331K
R8	RESISTOR, 22 OHMS, 1/2 W	28-198	RC20GF220K
R9,R10	THERMAL RESISTOR	28-825	KEYSTONE CARBON Co. L6605-2.5-59-S37
R11	RESISTOR, 27 OHMS, 1/2 W	28-200	RC20GF270K
R12	POTENTIOMETER, 20 OHMS, 2 W	29-153	RA20LASB200A
R13	RESISTOR, 68 OHMS, 1/2 W	28-197	RC20GF680K
R14	RESISTOR, 220 OHMS, 1 W	28-337	RC32GF221K
R15	POTENTIOMETER, 350 OHMS, 2 W	29-152	RA20NASD351A
R16	RESISTOR, 25 OHMS, 60 W	28-484	RW36G250
R17-R20	RESISTOR, 4. OHMS, 400 W	28-489	SORENSEN & Co.
R21	SHUNT, 200 AMPS	94-022	WESTON 9992
S1	SWITCH, D.P.S.T. NO.	45-062	SORENSEN & Co.
T1	TRANSFORMER	126-2112	SORENSEN & Co.
T2	TRANSFORMER, REFERENCE	126-2113	SORENSEN & Co.

For Reference see
Schematic drawing

D200-2639

dated

*

RECOMMENDED SPARE PARTS: This instrument normally requires the replacement only of tubes, pilot lamps, etc. However because of possible improper use, and because of the effects of high ambient and of certain kinds of tube failures (and of protective devices) we suggest that the parts marked with an asterisk be kept on hand. PLEASE REFERENCE THE MODEL AND SERIAL NUMBERS ON ALL PARTS ORDERS.

List No. 14-3255

Page 2 of 3

Prepared by J. CHAPKOVITCH

Date 11/15/60

SORENSEN & COMPANY, INC., 375 Fairfield Avenue, Stamford, Conn.

REPLACEMENT PARTS LIST

Model DISTRIBUTION PANEL (BATTERY CHARGER SECTION II)

Serial No. to

Schematic Symbol	Description	Sorensen Part No.	Specifications
CB1-CB12	CIRCUIT BREAKER	92-289	HEINEMANN TYPE AM12-MG3
DS1-DS12	PILOT LIGHT	42-326	SORENSEN & Co.
	PILOT LIGHT HOLDER	43-304	DIALIGHT 17410-931
DS13-DS24	PILOT LIGHT	42-323	G.E. 313
	PILOT LIGHT HOLDER	43-305	LH60PR4
DS25	LAMP FIXTURE	190-2475	SORENSEN & Co.
M1	AMMETER	94-418	SORENSEN & Co.
M2	VOLTMETER	94-531	SORENSEN & Co.
R1-R12	SHUNT, 50 A	94-019	WESTON 9992
R13-R24	RESISTOR, 0.2 OHMS, 225 W	28-488	WARD LEONARD 6-1/8" RIBFLEX
R25	POTENTIOMETER, 2 OHMS	29-155	RP301FD2ROKK
R26-R28	RESISTOR, 1 OHM, 78 W	28-486	RW37GIRO
R29	POTENTIOMETER, 2 OHMS	29-155	RP301FD2ROKK
R30-R32	RESISTOR, 1 OHM, 78 W	28-486	RW37GIRO
S1-S12	SWITCH D.P.S.T. N.O.	45-060	SORENSEN & Co.
S13-S22	SWITCH D.P.S.T. N.O.	45-061	SORENSEN & Co.
S25, S26	SWITCH, TOGGLE	45-142	MS35058-23
S27, S28	SWITCH, ROTARY	45-236	SORENSEN & Co.
S29	SWITCH, TOGGLE	45-141	MS35059-23
S23-S24	SWITCH, D.P.D.T. (Two "BREAK MAKES")	45-066	SORENSEN & Co.

For Reference see
Schematic drawing

D200-2640

dated

*

RECOMMENDED SPARE PARTS: This instrument normally requires the replacement only of tubes, pilot lamps, etc. However because of possible improper use, and because of the effects of high ambient temperatures and of certain kinds of tube failures (and of protective devices) we suggest that the parts marked with an asterisk be kept on hand. PLEASE REFERENCE THE MODEL AND SERIAL NUMBERS ON ALL PARTS ORDERS.

List No. 14-3255
 Page 3 of 3
 Prepared by J. CHAPKOVITCH
 Date 11/15/60



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JULY 20, 1961

APPENDIX C

COST REDUCTION SUGGESTIONS

FINAL ENGINEERING REPORT

SIGNAL CORPS BATTERY CHARGING SYSTEM PP2386

APPENDIX C
COST REDUCTION SUGGESTIONS

FOLLOWING IS A LIST OF SUGGESTIONS FOR REDUCING THE COST OF MANUFACTURING THE BATTERY CHARGING SYSTEM.

- A. ELIMINATE OR LESSEN THE MILITARY REQUIREMENTS ON CERTAIN PARTS AND MATERIALS. IN PARTICULAR, THE RUGGEDIZED HIGH SHOCK METERS COULD BE REPLACED BY STANDARD MILITARY COMPONENTS, OR COMMERCIAL UNITS. ALSO, COMMERCIAL STRUCTURAL MATERIALS, ESPECIALLY STEELS, HAVE A DEFINITE ADVANTAGE OVER THEIR MILITARY COUNTERPARTS IN TERMS OF PRICE AND AVAILABILITY.
- B. COMPLETELY ELIMINATE MILITARY SPECIFICATION ON ALL PARTS, MATERIALS AND PROCESSES.
- C. ELIMINATE WRITING TABLE AND LAMP.
- D. REPLACE INDIVIDUAL VOLTMETER AND AMMETER SWITCHES WITH ONE ROTARY TYPE SWITCH.
- E. ELIMINATE PILOT LIGHTS ON CONTROL PANEL; STATIONS BEING ENERGIZED ARE SUFFICIENTLY MARKED BY POSITION OF CIRCUIT BREAKER SWITCHES.
- F. FURTHER CONSIDERATION COULD BE GIVEN TO MAKING THE WOUND COMPONENTS CLASS S (130°C MAX.). THIS WOULD MEAN AN INCREASE IN THE SIZE OF THE COMPONENTS UNLESS THE MAXIMUM AMBIENT TEMPERATURE WAS REDUCED. A REDUCTION OF 10°C WOULD BE SUFFICIENT.
- G. ANY LESSENING OF THE VIBRATION REQUIREMENTS, TEMPERATURE AND HUMIDITY EXTREMES, OR REGULATION AND RIPPLE SPECIFICATIONS, WOULD RESULT IN THE LOWER COST OF COMPONENTS AND PARTS.
- H. ANY REDUCTION IN THE OUTPUT POWER OF THE SUPPLY WOULD SAVE ON THE EXPENSIVE ITEMS SUCH AS INPUT TRANSFORMER, MAGAMPS, FILTER CHOKE, AND RECTIFIERS. IS IT NECESSARY TO HAVE FACILITIES FOR CHARGING 12 BATTERIES SIMULTANEOUSLY?
- I. ELIMINATE BATTERY STATIONS, AND WIDEN THE CONTROL PANEL, OR INCREASE IT IN DEPTH, TO ACCOMMODATE THE BATTERY CHARGING OUTPUT TERMINALS (12 SETS). THE ADVANTAGES TO BE GAINED, OTHER THAN COST REDUCTION, ARE A SAVING IN FLOOR SPACE AND THE FACT THAT THE UNIT COULD BE DESIGNED TO FIT AGAINST A WALL.
- J. LIMIT THE SYSTEM TO BATTERY CHARGING. THIS WOULD REDUCE, OR ELIMINATE, THE REGULATION AND RIPPLE REDUCTION REQUIREMENTS. FURTHERMORE, THE POWER SUPPLY NEED NOT BE PORTABLE AND THEREFORE, THE SUPPLY AND CONTROL PANEL COULD BE COMBINED. THE RESULT WOULD BE A CONSIDERABLE SAVING IN BOTH SIZE AND COST.
- K. USE SORENSEN STANDARD POWER SUPPLY MODEL MA28-250.